DESTABILIZATION OF CRUDE OIL EMULSIONS VIA MICROWAVE ASSISTED ULTRASONIC TECHNOLOGY

by

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ABSTARCT

The conventional method of breaking emulsions using heat and chemicals are disadvantages from both economic and environmental aspects. Hence, the alternative method and environmental friendly are needed to alter efficiency for destabilization of crude oil emulsion. One of the alternatives that can be used to replace the existance chemical which is not enviromental friendly is by using microwave assisted ultrasonic technologies which create very high energy to break the presence of water in the crude oil. In this study, microwave assisted ultrasonic demulsification was applied in a 20-80 % and 50-50 % water-in-oil emulsions. The effectiveness of microwave assisted ultrasonic in demulsification was assessed experimentally with two different power of microwave which are 450 Watt and 600 Watt, and two different power of ultrasonic which are 3 and 9. A commercial emulsifiers used were Triton X-100, Low Sulphur Wax Residue (LSWR) and Span 83. The separation of water from crude oil is faster and efficient via using the microwave assisted by ultrasonic method compare to conventional method.

ABSTRAK

Kaedah-kaedah yang biasa digunakan dalam pemisahan air daripada emulsi air dalam minyak mentah seperti pemanasan dan penggunaan bahan kimia mendatangkan masalah dari segi ekonomi dan alam sekitar. Oleh itu, kaedah alternatif dan mesra alam yang diperlukan untuk mempercepatkan tahap kecekapan untuk proses pemisahan air daripada emulsi air dalam minyak mentah. Salah satu alternatif yang boleh digunakan untuk menggantikan bahan kimia yang telah wujud tetapi tidak mesra alam sekitar adalah dengan menggunakan teknologi gelombang mikro dibantu ultrasonik yang mewujudkan tenaga yang sangat tinggi untuk memecahkan kehadiran air dalam minyak mentah. Dalam kajian ini, pemisahan air dari minyak mentah melalui kaedah gelombang mikro dibantu ultrasonik telah digunakan dalam 20-80 % dan 50-50 % air dalam minyak emulsi. Keberkesanan gelombang mikro dibantu ultrasonik dalam proses pemisahan air daripada minyak mentah telah dinilai secara uji kaji dengan dua kuasa mikro yang berbeza iaitu 450 Watt dan 600 Watt, dan dua kuasa ultasonik yang berbeza iaitu 3 dan 9. Pengemulsi komersial yang digunakan adalah Triton X-100, Sulphur Rendah Wax Residu (LSWR) dan SPAN 83. Pemisahan air dari minyak mentah adalah lebih cepat dan cekap melalui kaedah gelombang mikro dibantu ultrasonik berbanding kaedah yang biasa digunakan.

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LIST OF SYMBOLS

$\varepsilon'_{r,w}$	-	Dielectric constant of water
$\varepsilon''_{r,w}$	-	Dielectric loss of water
$\varepsilon'_{r,o}$	-	Dielectric constant of crude oil
$\tan \delta_o$	-	Loss tangent of crude oil
$q_{MW,z}$	-	The volume rate of heat generation
A	-	Convective heat transfer area, cm^2
V	-	Volume of irradiated emulsion, cm^3
T_m	-	Temperature of emulsion, ^oC
T_a	-	Ambient Temperature, ^oC
ε	-	emissivity of surface
σ	-	Stefan-Boltzmann constant= 5.672 x 10^{-8} $W/m^2.K^4$
ρ	-	Density of emulsion, g/cm^3
C_p	-	Heat capacity at constant pressure, $cal/g.^oC$
$\frac{dT}{dt}$	-	Rate of temperature increase in $^oC/s$
ρ_m	-	Density of emulsion, g/cm^3
ρ_w	-	Density of water, g/cm^3
ρ_o	-	Density of crude oil, g/cm^3
$C_{p,m}$	-	Heat capacity of emulsion, $cal/g.^oC$
$C_{p,w}$	-	Heat capacity of water, $cal/g.^oC$
$C_{p,o}$	-	Heat capacity of crude oil, $cal/g.^oC$
Φ	-	Volume fraction of emulsified water

D_P	-	Penetration depth
c	-	Electromagnetic wave velocity = speed of light
f	-	Frequency
% water separation	-	Percentage of water separation

LIST OF ABBREVIATIONS

W/O	-	water-in-crude oil
O/W	-	crude oil-in-water
W/O/W	-	water-in-crude oil-in-water
LSWR	-	Low Sulphur Waxy Residue
HLB	-	Hydrophilic-Lipophilic Balance

CHAPTER ONE

INTRODUCTION

1.1 Background of the Proposed Study

Petroleum is a complex mixture of organic liquids called crude oil. The complex nature of the emulsions of water in crude oil is one of the main drawbacks to the development of techniques suitable for demulsification and phase separation in the oil

industry. Crude oil is come into two characteristics either it is light or heavy. It is light if it is a volatile oil and is heavy if it is viscous. Crude oil is commanly mingle with water. Normally, formations of stable water-in-oil (W/O) emulsions are frequently encountered in the oil industry. The content of natural emulsifier in heavy crude oil is many compare to the light crude oil, so the formation of emulsion in heavy crude oil is more stable. Crude oil containing water is harmful to the transportation, refinery, and also decrease the quality of the products. Emulsified water contains high concentrations of salts, mainly sodium chloride which influenced for corrosion during crude oil processing in refineries and can change the quality of final product. Destabilization is an important step to obtain water-free oil. The key area of this research is a separation, demulsification or breaking the crude oil by using microwave assisted ultrasonic. People will use chemical to break the crude oil because it is the cheapest method and very efficient. However, it creates another problem which is environmental problem. One of the alternatives that can be used to replace the existance chemical which is not enviromental friendly is by using microwave assisted ultrasonic technologies which create very high energy to break the presence of water in the crude oil.

1.2 Problem Statement

The presence of the water which carries carbon dioxide that is corossive can cause a lot of problems such as problems in reducing the quality of crude oil, pipeline and heater damaging. Furthermore, the demand of oil is higher but the sources are